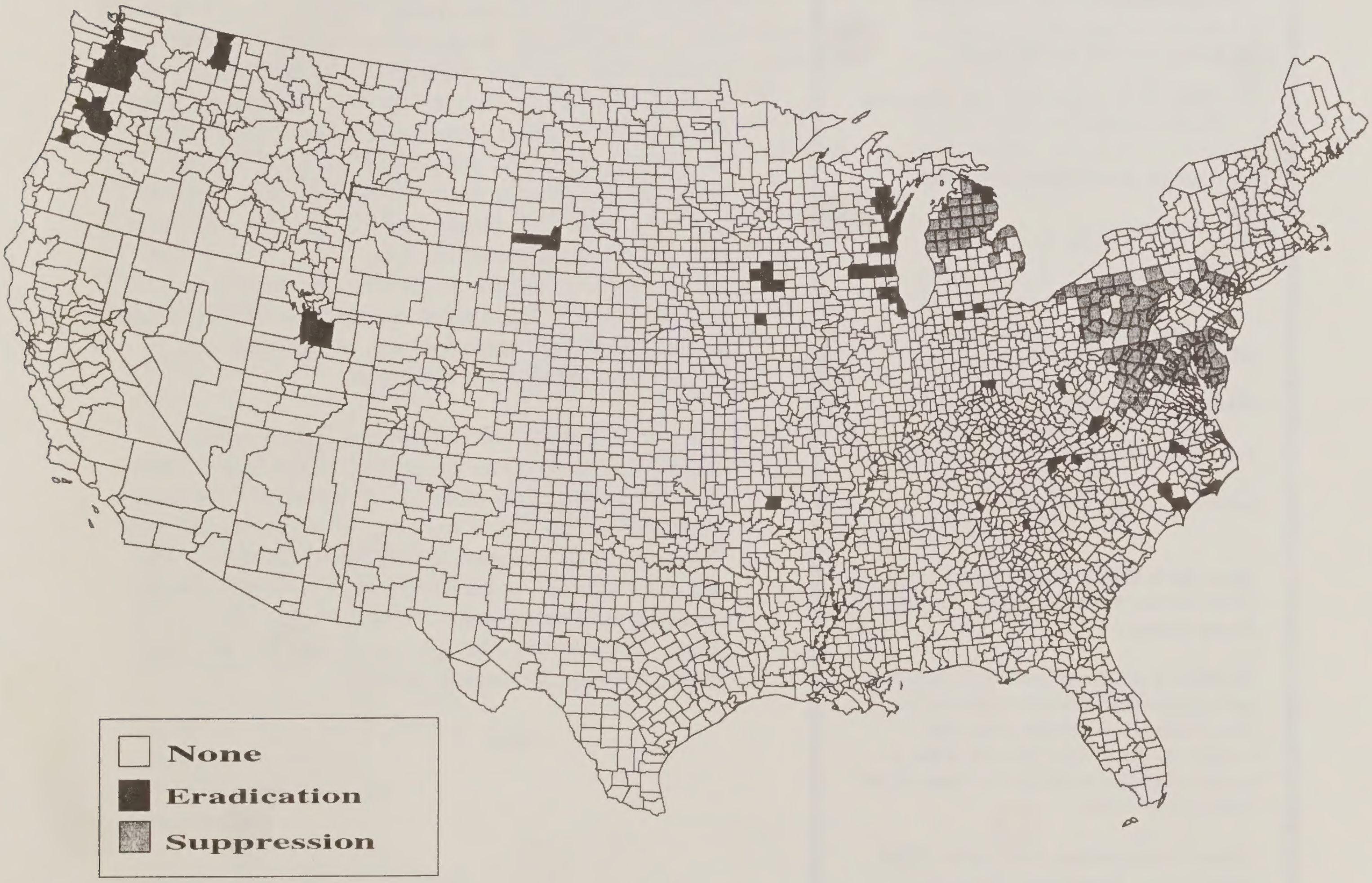
Gypsy Moth News

July 1993 Issue No. 32

Counties with USDA Gypsy Moth Suppression and Eradication Projects in the United States, 1993



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FOREST SERVICE
U.S.
DEPARTMENT OF AGRICULTURE
United States Department of Agriculture

NA
NORTHEASTERN AREA
State and Private Forestry

Contents

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From the Editor

The map on this issue's cover and our accompanying tables on pages 10 and 11 illustrate both the quantity and extent of suppression and eradication efforts in just one year. Suppression is a term used to reflect an attempt to reduce numbers of gypsy moth to nondamaging levels. It takes place in the East where gypsy moth is permanently established. Eradication is exactly that. An attempt to eliminate all life stages of the insect from an area. The objective is to eliminate the insect in hopes of slowing the spread. Gypsy moth is permanently established in New England, the mid-Atlantic States, Virginia, West Virginia, Ohio, and Michigan. Eradication of isolated infestations in places like Arkansas, Wisconsin, and Washington are attempts to slow the westward spread. Eradication is not a new effort. Various government agencies have been attempting to eradicate the gypsy moth for about 100 years. At this point in time, no one expects to eliminate the gypsy moth from North America. Present eradication of isolated infestations (those away from the main body) are viewed as an attempt to prevent new infestations and slow the spread. The Animal and Plant Health Inspection Service (APHIS), a regulatory arm of the USDA has primary responsibility for this effort.

You can read about one of these eradication projects taking place in Arkansas on page 12 of this issue. How on earth did the gypsy moth get to Arkansas? The same way it got to Salt Lake City, Utah--someone carried them. The gypsy moth egg mass is well suited for travel. The egg mass, attached to the underside of a camper, trailer, firewood, or lawn furniture, requires neither food nor water. Come Spring, the eggs hatch, and the wee little larvae crawl out to discover America.

-DBT

LETTERS TO THE EDITOR

W. K. from Rhinelander, WI asks:

> **"Has sufficient research been completed to prove that *E. maimaiga* does not infect native North American lepidoptera?"**

Dan Twardus responds:

I have sent a progress report of on-going studies by Drs. A. Hajek and L. Butler which you may find helpful (see page 2). In addition, you should be aware that the Wisconsin Department of Agriculture published an "Environmental Assessment for a Permit to Release *Entomophaga maimaiga* for the Biological Control of Gypsy Moth". Quoting from the Decision Document of this Assessment:

> "Published host range studies indicate that *Entomophaga maimaiga* infects only larvae of certain families in the order Lepidoptera, or butterflies and moths. However, the Department feels that there is not enough information on the pathogenicity of *E. maimaiga* to certain families of Lepidoptera to assess whether and the extent to which it may be able to infect threatened and endangered species of butterflies and moths in Wisconsin."

Apparently, as a result of this lack of information, the Department of Agriculture, Trade and Consumer Protection of Wisconsin therefore denied a permit for release of the fungus.

I think you will find in the Hajek report that results are inconclusive at this time. However, based upon conidial production, *E. maimaiga* infected larvae in three of the five suborders tested: Noctuoidea, Bombycoidea, and Geometroidea. Infection levels though, were very low. In answer to your question, "Has sufficient research been completed to prove that *E. maimaiga* does not infect native North American lepidoptera?", I would have to say that on-going research appears to indicate that native North American lepidoptera can be infected, though the significance of the infection level is yet to be determined. I also suggest that more definitive information relating to the topic can be obtained by writing to: Dr. Ann Hajek, Boyce Thompson Institute for Plant Research, Tower Road, Ithaca, NY 14853; or Dr. Linda Butler, West Virginia University, 1090 Agricultural Sciences Building, Morgantown, WV 26506. ★

B.S. in Princeton, NJ, writes:

> **"I'd like copies of reports on *Entomophaga maimaiga* listed in the April *Gypsy Moth News*".**

Dan Twardus responds:

All of the titles listed are studies that are underway and reports do not exist. However, Dr. Ann Hajek has been kind enough to forward to me progress reports of her studies which I have sent to you for your use. I suggest that if you require more definitive information about *E. maimaiga,* you contact Dr. Ann Hajek.

As reports of these studies are completed, I will publish their availability in the *News*. Information about the actual cooperative agreements authorizing these studies can be obtained by contacting Dr. Richard Reardon, USDA Forest Service in Morgantown, WV, at 304-285-1566. ★

EFFECTS OF THE FUNGAL PATHOGEN ENTOMOPHAGA MAIMAIGA ON NON-TARGET LEPIDOPTERA

By Ann E. Hajek and Linda Butler

Presented at the 1993 USDA Interagency Gypsy Moth Review in Annapolis, Maryland

In recent years, concern has been expressed over the impact of gypsy moth suppression programs on non-target arthropods. The gypsy moth fungal pathogen, *Entomophaga maimaiga* Humber, Shimazu & Soper, has caused epizootics in North American gypsy moth populations since its discovery in 1989. Previous work with a Japanese strain of *E. maimaiga* demonstrated that the fungus only infects Lepidoptera. We asked what impact *E. maimaiga* will have on the endemic North American lepidopteran fauna.

We challenged lepidopteran larvae with *E. maimaiga*, emphasizing field-collected larvae from West Virginia where *E. maimaiga* is not well established. Lepidopteran species for experiments were either reared from eggs, field-collected as larvae, or obtained from a laboratory colony. All larvae were reared on their preferred host plant species. Larvae were challenged with *E. maimaiga* by dipping them into a conidial suspension of known dose. Bioassays were successfully conducted using 43 species in 5 lepidopteran suborders: Papilionoidea (1 species), Pyralidoidea (1), Geometroidea (12), Bombycoidea (5), and Noctuoidea (24). We emphasized the Noctuoidea because this is the suborder that includes gypsy moth and the group that demonstrated infection in trials with the Japanese strain of *E. maimaiga*. *E. maimaiga* infected larvae in three of the five suborders tested: Noctuoidea, Bombycoidea, and Geometroidea. In all families beside Lymantriidae, infection was not uniform and infection levels were low. The four species of lymantriids treated became infected at levels from 60-100 percent. As a caveat, our results at this time reflect only bioassays conducted in the laboratory where infection by *E. maimaiga* was optimized. However, we know that the activity of *E. maimaiga* is partially dependent upon weather conditions and we hypothesize that the gypsy moth-specific larval movements and aggregations promote infection. Therefore, it is not known whether our bioassay results are any indication of levels of infection of alternate hosts under field conditions.

To determine the seasonality of resting spore germination, resting spores were placed in replicated bioassay boxes in the field and, beginning April 7, each week fourth-instar larvae were challenged until the end of August. Results from field bioassays indicate that resting spores began causing infections approximately two weeks before gypsy moth eggs began hatching. Larvae became infected until the end of July, when all gypsy moths pupated and many adults had emerged. Therefore, the activity of this fungus appears to be quite finely tuned to the seasonal appearance of gypsy moth larvae and pupae, although it appears to be active for a relatively brief period before egg hatch and for a time after most larvae had pupated. ★

Ann Hajek is an Entomologist with Boyce Thompson Institute, Tower Road Ithaca, New York 14853-1801.

Linda Butler is a Professor with the Division of Plant and Soil Sciences, P.O. Box 6108 West Virginia University, Morgantown, WV 26506-6108

GYPSY MOTH REARING PROBLEM LINKED TO IRON (Fe) IN DIET

By Thomas M. ODell, Melody A. Keena, John A. Tanner and Raymond B. Willis

Laboratory-reared gypsy moth are essential for research and for the production of the gypsy moth nuclearpolyhedrosis virus, F1-sterile egg masses, and sterile males used in operational programs. Until 1985, the New Jersey Standard Strain (NJSS) was an excellent production insect. It provided competitive adults for the sterile insect program, large larvae for virus production and consistent, relatively disease free larvae for research. However, beginning in late 1985, the Standard Strain, as well as other lab-reared gypsy moth strains, were subject to unpredictable periods of poor hatch, reduced survival, and slow asynchronous development. This was affectionately named, Abnormal Performance Syndrome, or APS.

In 1989, a research team developed a problem analysis and research action plan for solving the gypsy moth rearing problem (APS). The research objectives were: 1) to determine the cause of APS, 2) to develop methods for eliminating APS rearing problems from gypsy moth production systems, and 3) develop management protocols for preventing the reoccurrence of APS. The goal was to complete the research required to achieve our objectives within 3 years. This was accomplished.

Laboratory-reared gypsy moths produced at the USDA's Forest Service Insect Rearing Facility, Hamden, CT, and the Animal and Plant Health and Inspection Service's Methods Development Center, Otis Air National Guard Base, MA, account for approximately 95 percent of the gypsy moths used for RD&A in the United States. The New Jersey Standard Strain, produced at both facilities and now in its 39th generation, has become the white rat for scientists investigating methods for controlling this forest pest. The success of the APS research was due primarily to excellent cooperation between the Hamden and Otis research staffs and the support provided by each Agency. Scientists using Forest Service or APHIS produced gypsy moth can now be confident that they are once again receiving consistent, relatively disease free insects. Vendors of gypsy moth diet ingredients, cooperators, and others rearing gypsy moth, now have specific protocols for diet ingredients and methods for assessing the effects of changing diet ingredients.

After three years of intensive research, the cause of a gypsy moth rearing problem called Abnormal Performance Syndrome (APS), has been determined. Symptoms associated with APS are expressed when there is a dietary deficiency of available iron (see Table 1). This discovery has made it possible to eliminate APS as a significant problem in the production of gypsy moth for research, NPV production, and the development of the F1-sterile technique.

Iron is added to the standard gypsy moth high wheat germ diet (Bell et al. 1981) as ferric phosphate ($FePO_4$), one of 12 ingredients of Wesson Salt Mixture, a commercial mineral supplement. Between 1989 and 1992, the USDA Forest Service's Insect Rearing Facility, Hamden, Connecticut, and the USDA Animal and Plant Health Inspection Service's (APHIS) Methods Development Center, Otis ANGB, Massachusetts, purchased Wesson Salt Mixture (WSM) from two different vendors. These are identified here as WSM-A and WSM-B. When two consecutive generations of the New Jersey Standard Strain (NJSS), i.e., parents and progeny, were reared on diet containing WSM-A, APS had a significant negative impact on production. When the NJSS was reared for two generations on WSM-B, APS did not affect production. Alternating WSM-A and WSM-B by generation almost eliminated APS in the second generation; i.e., some symptoms were observed but production was not significantly affected. Subsequent chemical analysis of the two WSMs indicated that they differed primarily in the structure of ferric phosphate ($FePO_4$); WSM-A contained crystalline $FePO_4$, WSM-B contained amorphous $FePO_4$.

To determine if crystalline $FePO_4$ in WSM-A was the cause of APS, bioassays were conducted using diet containing $FePO_4$, and Wesson

Salt Mixture without $FePO_4$, each purchased separately from vendors A and B. $FePO_4$-A and $FePO_4$-B were mixed independently with each WSM prior to diet processing. APS symptoms were expressed only when gypsy moth were reared on diets containing $FePO_4$ purchased from Vendor A. Chemical analysis showed that $FePO_4$ from vendor A was crystalline and $FePO_4$ from vendor B was amorphous. Bioassays using other ferric compounds as substitutes for $FePO_4$ (e.g. ferric citrate, $FeC_6H_5O_7$) confirmed that iron was the component mediating the expression of APS.

In physical appearance, crystalline $FePO_4$ is salt-like in texture; amorphous $FePO_4$ is more powdery or flour-like. When added to water, amorphous $FePO_4$ forms a cloudy dispersion, crystalline $FePO_4$ settles rapidly to the bottom as crystals. Neither is soluble in water. Our studies indicate that the bioavailability of iron in gypsy moth diet is greater when $FePO_4$ is in the amorphous form, and that it may be possible to substitute other iron compounds for $FePO_4$. In addition, we have found that the expression of APS in the second generation can be affected by the method of diet production. The iron availability of amorphous $FePO_4$ appears to differ between diet batches made using an autoclave and a blender, hot plate and blender, and open or closed kettles with built-in mixers. For example, slow, asynchronous growth was observed when diet containing amorphous $FePO_4$ was processed using an autoclave and blender.

While the cause of APS has been identified, and a method for reducing or eliminating APS can be prescribed (see Recommendations), amorphous $FePO_4$ as a mineral supplement in gypsy moth diet does not appear to be a stable source of iron. Methods to stabilize and/or enhance the bioavailability of iron in gypsy moth diet are being investigated.

CONCLUSIONS RELATED TO SMALL SCALE AND MASS REARING OF GYPSY MOTH

- The potential for significant problems related to APS, including poor egg hatch and slow asynchronous growth (straggling), is induced in the parent by a deficiency in available iron. Induction occurs when parents are reared on diet which contains crystalline $FePO_4$ as the only supplementary source of iron.

- Poorer quality and often reduced numbers of egg masses are produced for use in the next generation when gypsy moth are reared continually on diet deficient in available iron.

- Straggling, the most visible expression of APS, is manifested only in progeny of induced parents and will significantly reduce production of gypsy moth when progeny are reared on diet which contains crystalline $FePO_4$ as the only supplementary source of iron.

- APS is significantly reduced or eliminated when progeny of parents reared on diet containing crystalline $FePO_4$ (induced) are reared on diet containing either amorphous $FePO_4$ or $FeC_6H_5O_7$.

- When both parents and progeny are reared on diet containing crystalline $FePO_4$, the incidence of APS varies between and within families (egg masses).

- Progeny reared from field collected eggs on diet containing crystalline $FePO_4$ express significant APS symptoms, but siblings reared on diet containing amorphous $FePO_4$ do not. This indicates that induction occurred in the parent in the field and that successful establishment of new laboratory colonies is likely to depend on the bioavailability of iron in the laboratory diet.

- Consistent use of Wesson Salt Mixture which contains the amorphous form of $FePO_4$ can significantly reduce and/or eliminate the rearing problems associated with APS in the standard laboratory production strains.

RECOMMENDATIONS

Wesson Salt Mixture is widely used in insect diets because it has given satisfactory results, despite its recognized imbalance of salts for insects. Commerical Wesson Salt Mixtures are modifications of the original formula and, as we have found, these modifications may vary between vendors and may significantly effect production of insects.

Of equal importance, APS research has demonstrated that the effects of changes in diet formulation may not be expressed and/or detected in the first generation and that sensitivity to dietary changes has a genetic basis. To ensure these variables and other APS research

findings are accounted for, the following production management actions should be followed:

- To eliminate or significantly reduce the occurrence of APS, orders for Wesson Salt Mixture should specify that $FePO_4$ meets the Food Chemicals Codex (FCC) specifications as provided for in the FCC, 3rd Edition (1981).

Table 1.--Quantitative Assessment of APS Symptoms

Slow asynchronous growth (straggling)	
	. mean larval stage at 10 days
	. % pupation at 34 days
	. mean days to adult eclosion
Reduced hatch of embryonated eggs	
	. % hatch of embryonated eggs
Reduced survival	
	. % larval mortality at 10 and 34 days
	. % pupal mortality
Increased female pupal deformity	
	. mean female pupal banding

- Specifications (standards) for all diet ingredients should be used consistently in purchasing. For example, the 12 minerals in Wesson Salt Mixture should be specified by formula (also see first recommendation).

- Storage of diet ingredients should ensure that specifications are maintained. Suppliers indicate that placing ingredients in plastic bags to exclude moisture, and storing in a freezer is adequate for maintaining ingredients for up to 1 year. However, as a general rule, wheat germ should not be stored for more than 6 months.

- Each change in diet formulation should be tested independently for a minimum of two generations.

- Bioassays to determine effect of diet modification on production of NJSS or wild strains should include a minimum of 25 families, 20 insects/family (see Table 2), with each family treated as a test variable.

- Variables used to quantify expression of APS should be sufficient for detecting most diet deficiencies (Table 1).

- Variability in gypsy moth laboratory colonies should be conserved and/or increased so that inadvertent selection for more sensitive genotypes and inbreeding depression are avoided.

Table 2.
Standard APS Bioassay

Insects:
25 families (egg masses),
20 neonates/family/treatment
Containers:
6 oz fluted plastic cups with cardboard lids, 10 insects/cup
2/family/treatment
Diet:
Standard wheat germ diet (Bell et al. 1981), 40 or 80 ml diet/cup
Environment:
Walk-in chamber set at 25°C, 50-60% RH, and 16:8 L:D

- The recommendations noted above should be used routinely to make decisions on all proposed changes in standard production/rearing procedures.

This research was initiated in 1990 following a "high priority" request by the USDA Gypsy Moth Working Group. The success of the APS research was due to the excellent interagency cooperation and the support provided by each agency. For more information, call Tom ODell or Melody Keena at 203-773-2024 or 202-773-2297, respectively.

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National Research Council. 1981. Food Chemicals Codex, 3rd Edition. National Academy Press, 2101 Constitution Avenue, NW, Washington, D.C. 20418. ★

Thomas M. ODell and Melody A. Keena are Research Entomologists and Raymond B. Willis is a Chemist with the USDA Forest Service, Northeastern Forest Experiment Station in Hamden, CT. John A. Tanner is an Entomologist with the USDA Animal and Plant Health Inspection Service, Otis ANGB, MA.

Update on the National Gypsy Moth EIS

By Jill Cherpack

In the February 1992 issue of *Gypsy Moth News*, Robert D. Wolfe of the USDA Forest Service, Forest Health Protection Staff, reported that the Forest Service and Animal and Plant Health Inspection Service (APHIS) had formed a team to review the 1985 environmental impact statement (EIS) for gypsy moth suppression and eradication projects and set a course for action. Here's what's occurred since that time, and what happens next.

An EIS is an analytic document that is legally required for Federal actions that may affect the environment. The team's first challenge was deciding whether to do a new EIS or a supplement to the 1985 EIS. After meeting with cooperators, scientists, resource and agency managers, it was decided that a fresh look at the gypsy moth problem was needed and a new EIS should be done. The new EIS will be national and programmatic, with the objective of controlling unacceptable damage to high value forests and shade trees. It will be strategic, giving general Federal guidelines and leaving site-specific decisions to resource managers who will implement the guidelines. Both the European and Asian gypsy moth will be addressed.

The next step was forming a network of Forest Service and APHIS public affairs and forest pest managers to reach the interested public nationwide. This network also provides the technical direction needed to ensure that the EIS reflects conditions in all parts of the United States. In July 1992, the public affairs contacts from as far as Alaska met in Philadelphia, reviewed the team's draft public involvement plan, and discussed coordination needs and ideas for reaching target groups.

In November 1992, the team published in the *Federal Register* a Notice of Intent to prepare a new EIS. The notice kicked off a 120-day public comment period, which closed in March 1993.

Public involvement efforts were extensive. Informational items were developed to explain the gypsy moth problem and the EIS process in plain language. Dozens of presentations were made to groups across the country. Over 22,000 letters were mailed requesting public comment on the gypsy moth problem and ways to manage it. Employees of the Forest Service and APHIS were also invited to comment. The team's national network was vital in supporting the information campaign, providing mailing lists, reaching the media, answering questions and providing public involvement opportunities. Over 800 public comment letters were received, many with detailed recommendations.

Eleven analysts and clerical staff were detailed to the EIS team for 3 weeks in spring 1993, to review the public's letters. In this process, substantive comments from each letter are identified and coded according to subject matter. Each comment is entered into a database, a computer program groups all comments on a given subject, and an organized picture of the public issues emerges.

Work has begun on some of the technical requirements of the project, including an updated assessment of risks to human health from approved insecticides. Risks to nontarget organisms from both gypsy moth defoliation and treatment methods will also be assessed. Computer modeling will map forests at risk and estimate the effects of gypsy moth defoliation on short and long term changes in forest vegetation for all susceptible U.S. forest types.

The next part of the project is developing the draft EIS, which will examine alternative ways to manage the gypsy moth problem. Comments and concerns raised by the public will shape much of the draft EIS. The merits, pitfalls, social, economic and environmental effects of each way will be explored, and a preferred alternative will be recommended. The option of no action--meaning no Federal gypsy moth program--will also be explored.

The draft will be available for public review in summer 1994 and will be accompanied by another major public outreach effort. Public response to the draft will be analyzed and incorporated into the final EIS.

For more information, call John Hazel, EIS Team Leader, at (215) 975-4150. ★

Jill Cherpack is a Public Affairs Specialist with the USDA Forest Service, National Gypsy Moth EIS Team, in Radnor, PA.

Understanding The Ecological Effects of Gypsy Moth

By R. M. Muzika

For several decades researchers have sought information on the gypsy moth--its life history characteristics, population dynamics, control, and perhaps most importantly, its consequences. After all, if the consequences of gypsy moth were minimal, it's doubtful that prodigious amounts of money would have been consumed investigating and eradicating this pest. The work of a hundred years has informed us that the effects of gypsy moth are numerous and at times severe. Although some may be reluctant to admit it, many of these significant consequences can be subsumed under the category of ecological effects. Despite an enduring history of defoliation, a seemingly continuous barrage of the gypsy moth, and numerous studies, very little can be stated definitively about the ecological effects of gypsy moth.

Obviously, gypsy moth defoliation and subsequent mortality of valuable trees represent a dominant concern. Growth impacts and possible mortality are fairly well understood, yet data suggest that these are highly variable. Predicting and understanding the effect gypsy moth might have on mortality does not indicate anything about the ecological ramifications of the mortality. Trees are only one component of a forest, and defoliation and tree mortality influence more than overstory species, encompassing other organisms and ecological processes. Yet, the "after effects" of gypsy moth-induced defoliation remain relatively unexplored. In other words, there is more to gypsy moth than just tree mortality.

It would seem our vision has been limited, and that we've dealt with short-term impacts and primarily economic or visual concerns, relegating long-term ecological impacts to a subordinate position. Understanding ecological impacts is becoming increasingly important, particularly accompanying the emphasis on ecological management of natural resources and with attempts to set aside special areas, such as old growth, research natural areas, botanical areas, or critical wildlife habitats. The apparent benefits of research to assess long-term ecological impacts are numerous.

This is not to say that ecological impacts of gypsy moth have been neglected entirely. For example, studies have indicated differential mortality associated with varying site conditions, therefore, the ecological impact varies with site. Such a finding is not surprising, yet we know little more than that. This information, in concert with overstory species composition, has essentially provided us with the basis for hazard rating. It's necessary, however, to explore further questions, such as, what specific site factors may be responsible for differential mortality? Which ecological processes may play a role in mortality? Also, there is considerable interest in overstory species that replace the mortality, but, we know very little about the resilience of the understory vegetation. These shrubs and herbaceous vegetation may serve as indicators of productivity and site potential, and their presence, absence, and abundance could provide significant information about the ability of the overstory to recover, as well as post-mortality productivity and species composition.

Some specific questions to be addressed when exploring ecological impacts include:

Are ecological effects predictable? Do these differ by region?

Because of the wide variety of tree species on which the gypsy moth feeds, it is likely to invade most the country. Forests are not uniform, nor would all forest ecosystem characteristics be identical. A familiarity with the effects of gypsy moth in New England forests may furnish little or no insight for understanding effects in Appalachian forests or in the Lake States. On the other hand, there may be surprising and unexpected similarities. White pine and several oak species represent good examples of species with extensive distributions throughout the Northeast; however, the relative ecological roles of these species in forest communities would not be the same. In different areas of their ranges, these species could be found on a variety of soil types, landforms, and in different plant associations. In terms of dominance and interaction with other species, the ecological roles of oaks and

white pine in New England would likely differ from the role of these species in Appalachian ridge and valley forests or in the Lake States.

Does defoliation by gypsy moth influence populations of other animals?

Other important components of the forest system that are likely to be affected by gypsy moth include resident populations of other invertebrates, as well as mammals and birds. Understanding the effects on these organisms is important because many serve as predators of the gypsy moth. We have very little information explaining changes in habitat conditions caused by gypsy moth defoliation, but obviously populations are likely to respond to defoliation, canopy openings, and fragmentation.

What are the effects on vegetation structure and function?

Ecological effects include not only direct effects such as defoliation and mortality, but indirect effects as well. Gypsy moth-related mortality has the potential to affect the competitive ability of plant species. Similarly, a reduction in tree growth, another direct consequence of gypsy moth defoliation, affects the balance of competition among plant species. Removal of any number of overstory individuals will likely influence shrubs and herbaceous species, and in most cases the ground flora layer increases substantially. The herbaceous response may be sufficient to prevent establishment or growth of overstory species, or at a minimum, only those overstory species that compete well in such circumstances will prosper. It is not surprising then, to expect a very different plant community following severe mortality.

Current and future research:

There are obviously some gaps in the knowledge of ecological impact. To advance our understanding of a complete array of gypsy moth influences on forest ecosystems, several projects are underway. Among these is a study examining changes in plant species composition following defoliation. This includes plant species diversity changes with time and with varying levels of gypsy moth defoliation. Research efforts using silvicultural manipulation are incorporated in such studies and can help determine not only which silvicultural treatments may minimize direct gypsy moth impact, but also which treatments allow for the greatest ecological stability.

Vegetation in all structural layers is included in these analyses. Although historically, there's been a lack of attention to non-woody species, research has demonstrated value in understanding the entire vegetation complex. Herbaceous species and shrubs may provide indicators of site productivity, likely plant communities, and wildlife habitat. Indeed, the value of non-woody species is becoming increasingly apparent as an integral part of the forest ecosystem.

Studies are underway to determine the effects of gypsy moth defoliation and mortality on populations of invertebrates and vertebrates and to examine the effects of silvicultural treatment on natural enemies. The objectives of these studies include surveying and quantifying the populations of several groups of potential gypsy moth predators such as ants and spiders among other invertebrates, along with looking at changes in small mammal populations.

Populations of secondary organisms, i.e., the mortality agents following gypsy moth defoliation, contribute substantially to the cumulative ecological impact of gypsy moth. Current studies examine populations of both the twolined chestnut borer (*Agrilus bilineatus)* and shoestring rot (*Armillaria,* spp.), two of the most important mortality-causing agents following defoliation. Specific attributes in these analyses are site and defoliation influences on the secondary organisms, determining the conditions that promote populations, and assessing the change in chestnut borer populations and *Armillaria* during an outbreak.

A promising approach to studying ecological impact of gypsy moth incorporates gypsy moth hazard rating with multifactor ecological classification. Ecological classification is a fine scale forest typing method, based on many components of the ecological landscape; thus ecological units are not necessarily recognizable based strictly on overstory species. At this finer level of resolution we may discover that gypsy moth defoliation is associated with particular topographic features, soil types, or more likely, a characteristic combination of several ecological attributes. Moreover, ecological types are apt to vary in degree of susceptibility, vulnerability and potential mortality. Using ecological classification methodology will assist in determining the critical site characteristics associated with overstory mortality and survival.

Is there some utility in understanding ecological effects of gypsy moth? Predicting the response of a forest to defoliation and mortality provides the greatest benefit. Heightened awareness of ecological issues such as biodiversity and fragmentation, forest health, and ecosystem management necessitates a more ecologically sound approach to managing the gypsy moth. Only through studying the ecological consequences of gypsy moth defoliation and mortality will this approach be meaningful. ★

R.M. Muzika is a Research Ecologist with the USDA Forest Service Research Work Unit, Silvicultural Options for the Gypsy Moth, in Morgantown, WV.

GYPSY MOTH DIGEST (GMDigest)

By Helen A. Machesky

The Gypsy Moth Digest (GMDigest) is an historical database which contains information (acreages and dollars) associated with gypsy moth suppression, eradication, and defoliation.

The acreages for gypsy moth suppression and eradication are compiled from projects where the Forest Service either provided all (Federal lands) or part (State and Private) of the funding for the years 1970 to present. The data does not include projects which were conducted by private organizations. Suppression costs include the total cost (State share and Forest Service share) of conducting a Cooperative Gypsy Moth Suppression Program, but do not include costs for other Federal projects.

The data for gypsy moth defoliation includes all ownerships--State Cooperative, National Forest, and Other Federal--for the years 1924 to present.

The GMDigest is a service provided by the USDA Forest Service, Forest Health Protection, Morgantown, WV. The GMDigest is updated yearly and hardcopy updates are available for distribution on or about January 1 of each year.

Work is now underway to make the GMDigest available on a diskette using Microsoft Access' run-time version of the software. User's will be able to generate reports and graphs displaying suppression, eradication, and defoliation data for the year(s) of their choice.

For more information about the GMDigest, contact Helen at 304-285-1548. ★

Helen Machesky is a Computer Programmer Analyst with Forest Health Protection in Morgantown, WV.

GYPSY MOTH SUPPRESSION AND ERADICATION PROJECTS, 1993[1]

STATE	DIMILIN	BT	OTHER	TOTAL
COOPERATIVE				
Delaware	4255	14817	0	19072
Maryland	15696	25154	0	40850
Michigan	0	225843*	0	225843
North Carolina	0	360	0	360
New Jersey Ag	0	12309	0	12309
Ohio	2738	1700	0	4438
Pennsylvania	78857	29860	0	108717
Virginia	40035	21419	0	61454
West Virginia	58535	3090	0	61625
NATIONAL FOREST				
Huron-Manistee	0	2004	0	2004
Allegheny	0	16485*	0	16485
Geo. Washington	688	6130	25	6843
Monongahela	0	7281	2724*	10005
OTHER FEDERAL				
Blackwater NWR, MD	0	0	158*	158
C&O Canal, MD	0	0	85*	85
Eastern Neck NWR, MD	0	0	220*	220
Harpers Ferry NP, MD	0	430	0	430
National Capital Region-E, MD	0	150	0	150
Shenango River Lake, PA	0	33	0	33
Blue Ridge Parkway, VA	828	537	0	1365
Manassas NBF Park, VA	0	400	0	400
Prince William Forest, VA	0	296	308*	604
Quantico Mariene Base, VA	3440	926	0	4366
Shenandoah NP, VA	1176	0	0	1176
Harpers Ferry NP, WV	0	150	0	150
ERADICATION				
White County, GA	0	1937*	0	1937
Wash. & Sequatch. County, TN	0	840*	155*	995
Uinta NF, UT	0	966**	0	966
Wasatch Front, UT	0	2415**	0	2415
Wasatch-Cache NF, UT	0	1755	0	1755
Wisconsin	0	32870	0	32870
WVDA Regulatory	120	0	0	120
SLOW-THE-SPREAD				
White's Fork, NC	0	3200*	0	3200
Jefferson NF	0	0	2248	2248
Virginia S&PF Lands	0	0	338	338
West Virginia S&PF Lands	0	0	237	237
TOTAL	206368	413357	6498	626223

*Double applications on some or all of these acres.
**Triple applications on some or all of these acres.

[1]Forest Service-funded projects.

GYPSY MOTH ERADICATION PROJECTS, 1993[2]

STATE	TREATMENT	APPROXIMATE ACRES[3]
ARKANSAS		
Newton County	Dimilin-aerial and Mass Trapping	23,600
ILLINOIS		
Cook, Lake, and McHenry Counties	Bt-aerial and Mass Trapping	671
INDIANA		
Noble County	Mass Trapping	7
IOWA		
Butler, Cerro Gordo, Franklin, Hancock, Polk, and Worth Counties	Bt -aerial and ground	75
NORTH CAROLINA		
Pender, Sampson, Carteret, and Ashe Counties	Bt-ground and Dimilin-ground	17
OHIO		
Hamilton and Williams Counties	Mass Trapping	130
OREGON		
Benton, Multnomah, and Clackamas Counties	Bt-aerial and ground	451
SOUTH DAKOTA[4]		
Pennington County	Mass Trapping	25,000
WASHINGTON		
Clark, King, Kitsap, Lewis, Pierce, Stevens, and Thurston Counties	Bt-ground	120
WEST VIRGINIA		
Jackson County	Mass Trapping	16
WISCONSIN		
Dane, Jefferson, Waukesha, Brown, Milwaukee, Door, Fond Du Lac, Sheyoygan, Kewaunee, and Manitowoc Counties	Bt-aerial and Mass Trapping	3,643

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[2]APHIS-funded projects.

[3]Acreages are subject to change upon verification from APHIS.

[4]Forest Service-funded project.

ARKANSAS' NEW RESIDENTS ERADICATED

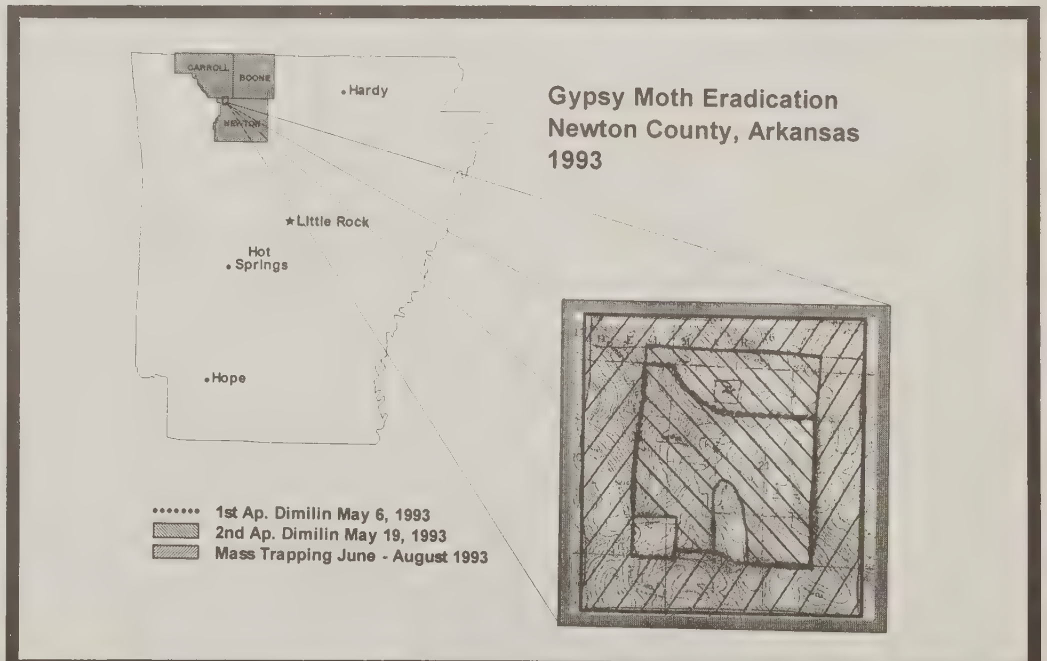
By Bobbe Fitzgibbon

As now-President Bill Clinton was making his plans to leave Arkansas, new unwelcome residents were found in Newton County. In 1992, an increase in the trapping intensity near Compton, in northwestern Arkansas, led to the discovery of a small but dense population of gypsy moth. The infestation is located 2.3 miles northwest of the town of Compton. The only previous history of gypsy moth in Arkansas involved the eradication of a small established population near the town of Hardy in 1982.

The responsibility for annual pheromone trapping surveys in Arkansas is shared by the Arkansas State Plant Board (ASPB), the Animal and Plant Health Inspection Service-Plant Protection and Quarantine (APHIS-PPQ) and the Forest Service (FS). Surveys are conducted in accordance with the APHIS National Gypsy Moth Survey Plan. Actual trapping is done by fifteen cooperating agencies within the state. Isolated infestations identified by the annual surveys are eliminated in an effort to prevent the establishment of new infestations that will lead to impacts and quantities.

Two positive catches in pheromone traps near Compton during the 1991 trapping season triggered increased trapping in 1992. A mid-season trap check in late June of 1992 yielded three positive single male moth catches: one on the Buffalo National River; one, 1 mile southeast of Compton; and one at Plumlee Cemetery, 0.8 miles south of the core of infestation. A total of 18 moths were caught in 8 traps in Newton County in 1992. The infestation was found to be in a wooded area of 40 to 50 acres associated with a private residence. The infestation dates back to 1984 or 1985 when a camper from Connecticut was parked at the residence for a extended period of time. Because the Newton County infestation is located approximately 750 miles from the generally infested area, an eradication project was indicated.

A public hearing to initiate the decision process was held on January 13, 1993. Gerald King, Director of the ASPB, served as the moderator, Travis Burrnett and Win McLane represented APHIS. There was no serious opposition to the proposed treatment; the major concern of those present was the complete eradication of the gypsy moth from the area. The Environmental Assessment prepared by APHIS in cooperation with ASPB documents the decision process. The decision was made to treat a 600 acre block with two applications of Dimilin 4L at a rate of 0.03 lbs. of active ingredient/acre by helicopter. A Bell 47G2 was used. On May 5, 1993 the first application of Dimilin began. Thirty-nine acres were treated



before mechanical problems and weather conditions delayed completion until the morning of May 6, 1993. Larval blow-out to the northeast of the infestation was noted. On May 19, 1993, the second treatment was applied to 570 acres. The treatment block was adjusted to include the majority of the area where blow-out was observed. Sections of the initial block were omitted where no sign of larval activity was noted. Larval trapping will be done in the core area and in areas where blow-out was noted. The project was supervised by Win McLane and James Thompson both of APHIS and Don Alexander and David Blackburn both of ASPB.

A mass trapping grid of 3 traps/acre, 1/4 section wide, has been deployed around the treated area. These traps will be checked every 2 to 3 weeks from early June to late August. Delimiting-trapping around the mass-trapping grid will consist of approximately 3,000 traps in a 36 square-mile area.

Have we removed this group of unwanted newcomers from the hardwood forest of northern Arkansas? Only time and trapping will tell. Hopefully, it will be many years until the raining of caterpillar frass interrupts the normal night sounds of Mr. Clinton's home State. ★

Bobbe Fitzgibbon is an Entomologist with the USDA Forest Service, Forest Pest Management Staff in Pineville, LA.

New Publication

Defoliation potential of gypsy moth by D. A. Gansner, D. A. Drake, S. L. Arner, R. R. Hershey, and S. L. King. 1993. USDA Forest Service, Northeastern Forest Exp. Station, NE-INF-117-93.

A model that estimates the likelihood of gypsy moth defoliation was applied to recent inventory plot data to produce susceptibility ratings and maps showing defoliation potential in a 7-State area where gypsy moth is an immediate threat.

A copy of this publication is included with this issue of the *Gypsy Moth News*. For more copies of this publication, contact Dave Gansner at 215-975-4044. ★

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